MISSOURI HAZARD ANALYSIS

Prepared by:

STATE EMERGENCY MANAGEMENT AGENCY
STATE OF MISSOURI
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Matt Blunt
Governor

STATE OF MISSOURI

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M E M O R A N D U M

To: ALL STATE-WIDE HAZARD ANALYSIS HOLDERS

From: Ronald M. Reynolds, DIRECTOR OF SEMA

This revised Missouri State-wide Hazard Analysis is the result of the collective efforts of all the branches of SEMA. This analysis assesses various risks facing the state and its communities so that the risks can be evaluated and ranked. This process is then used to characterize hazards for emergency planning. It estimates the probability of occurrence and the severity of consequences for each hazard and provides a method of comparison.

We are pleased to present the FY '05 revisions to the State Hazard Analysis in loose-leaf format to insert in your copy of the plan. Each year, we will forward those annexes that have been revised or updated when they are completed by our staff.

State agencies and local jurisdictions should use this hazard analysis for planning, prioritization, and resource allocation. The information contained herein should identify capabilities essential to disaster response; for determining the probable effectiveness of allocating resources in emergency situations; and for encouraging the cooperation of various political subdivisions and emergency services in formulating regulations, plans and programs in order to mitigate disasters and minimize loss of life, human suffering, and damage to public and private property.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

PURPOSE

The emergency management community now faces threats in many ways different than past threats. Gone are the days when emergency management was only for natural disasters and nuclear preparedness. We now face more technologically and politically based hazards that demand the attention of the emergency management community. These new hazards include a number of threats that have not been adequately dealt with in the past, including hazardous materials releases, civil disorders, and terrorism.

This document has been compiled to identify the multiplicity of hazards that exist at varying locations and degrees of magnitude throughout the state and to determine the potential impacts of these hazards on residents, property, and the environment. The information contained herein identifies capabilities essential to disaster response, for determining the probable effectiveness of allocating resources in emergency situations, and for encouraging the cooperation of various political subdivisions and emergency services in formulating regulations, plans, and programs to prepare for disasters and minimize loss of life, human suffering, and damage to public and private property. In addition, a thorough hazard analysis provides a foundation for educating senior government officials and the public on dangers posed by various hazards.

This Hazard Analysis assesses various risks facing the state and its communities in order to evaluate and rank them. This process is then used to characterize hazards for emergency planning. It estimates the probability of occurrence and the severity of consequences for each hazard and provides a method of comparison. The evaluation involves many interrelated variables (toxicity, demographics, topography, etc.), and should be used by state and local officials in planning and prioritizing allocation of resources.

The hazards presented here are those that have been experienced by, or pose a potential threat to, Missourians. However, local or isolated problems that constitute potential disasters should not be overlooked.

The following definitions explain the ratings for each hazard:

Probability: The likelihood that the hazard will occur.

Low	The hazard has little or no chance of happening.
Moderate	The hazard has a reasonable probability of occurring.
High	The probability is considered sufficiently high to assume that the event will occur.

Severity: The deaths, injuries, or damages (property or environmental) that could result from the hazard.

Low	Few or minor damages or injuries are likely.
Moderate	Injuries to personnel and damages to property and the environment is expected.
High	Deaths and major injuries and damages will likely occur.

The hazards covered in the analysis are listed below, along with the overall rating they were given. The ratings presented below are situational dependent.

Tornadoes/Severe Thunderstorms
Probability: High
Severity: High

Dam Failures
Probability: Low
Severity: Moderate

Heat Wave
Probability: Moderate
Severity: Moderate

Severe Winter Weather/Snow/Ice/Severe Cold
Probability: High (North of Missouri River)
Probability: Low (South of Missouri River)
Severity: Moderate (North of Missouri River)
Severity: Moderate (South of Missouri River)

Attack
(Nuclear/Conventional/Chemical/Biological)
Probability: Low
Severity: High

Utilities (Interruptions and System Failures)
Probability: High
Severity: Low

Public Health Emergencies/Environmental Issues
Probability: High
Severity: Moderate to High

Nuclear Power Plants (Emergencies/Accidents)
Probability: Moderate
Severity: Moderate

Floods (Major and Flash)
Probability: High
Severity: High

Special Events
Probability: Low
Severity: Low to High

Drought
Probability: Moderate
Severity: Moderate

Earthquakes
Probability: High
Severity: High

Fires
(Structural & Urban)
Probability: High
Severity: Moderate

(Wild)
Probability: Moderate
Severity: Low to Moderate

Terrorism
Probability: Low
Severity: Low to High

Mass Transportation Accidents
Probability: Moderate
Severity: Moderate

Hazardous Materials
(Fixed Facility Accidents)
Probability: Moderate
Severity: Moderate

(Transportation Accidents)
Probability: High
Severity: Moderate

Civil Disorder
Probability: Low
Severity: Low to High

INTRODUCTION

Because Missouri is located in the middle section of the United States, it is prone to several kinds of natural hazards. Missouri has a continental climate; in other words, the weather is changeable and has large variations in temperature and precipitation.

Missouri serves as a major thoroughfare for transportation and has an abundant share of industrial, agricultural, and recreational facilities. Thus, man-made disasters can occur, such as hazardous materials releases, fixed nuclear facility incidents, and other emergencies caused by human action.

Missouri has four topographically distinct regions: glaciated plains in the north, plains or prairie in the west, lowlands in the extreme southeast, and the Missouri Ozarks in between.

The plains section, both glaciated and unglaciated, encompasses nearly all the area north of the Missouri River and a large area south of the river in the western part of the state. The topography varies from rolling hills in the east to hills in the west that average about 450 feet above sea level. There are numerous wide, flat valleys cut by the river.

The Ozarks, which comprise about half of the state, are characterized by rugged areas of sharp ridges and deep narrow valleys. Elevations range from about 1,000 to more than 1,600 feet above sea level.

The southeastern lowlands cover about 3,000 square miles, with elevations from 230 to 300 feet above sea level. Much of the region is excellent farmland, channeled by an extensive system of drainage ditches.

Because the state is situated along two of the continent's greatest rivers, the Missouri and the Mississippi Rivers, the potential for great floods is high. While six large flood control dams have been built on the mainstream of the Missouri River, they have not eliminated the flood threat.

Warm and cool air masses often collide along sharply divided "fronts," accompanied by violent thunderstorms having intense rains, strong winds, hail, and occasional tornadoes. These frontal storm systems can pass across the state at any time of the year, but are most frequent during the spring months (March, April and May). There are two important truths about Missouri's weather: (1) the state is subject to weather extremes, and (2) extreme weather changes can occur rather quickly.

Most of the natural disasters that occur in Missouri (except for earthquakes, land subsidence, and possibly dam failures) result from a weather extreme or an extreme weather change. Because Missouri is situated in the center of the United States, it is subject to many different influences that determine weather patterns.

According to Dr. Grant Darkow [1], Department of Atmospheric Science at the University of Missouri-Columbia, specific recognizable weather patterns are responsible for Missouri's weather, especially those that "tend to produce extremes in precipitation, resulting in unusually wet or drought conditions, and extremes in temperature, either abnormally warm or cold." Darkow explains, "The character of air over Missouri on any particular day or series of days is dominated by the source regions from which it comes. Missouri's mid-continental location makes it subject to air flows from a variety of source regions with markedly different properties.

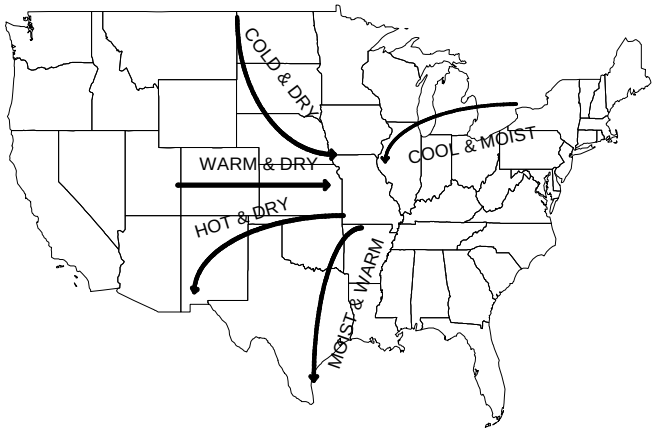
The state is close enough to the Gulf of Mexico that warm air with high humidity can flow into the state from a southerly direction at almost any time of the year. This warm, moist air is the principal source of spring, summer, and fall precipitation and, occasionally, precipitation in winter as well.

In contrast, air arriving over Missouri from semi-arid to arid regions to the southwest is warm or hot and usually dry. Air that has moved from west to east over the Rocky Mountains arrives warm and dry, having lost most of its low-level moisture as it climbed the west side of the mountains.

Abnormally cold air in the winter and cold summer air with only very small moisture content arrives over Missouri from the northwest or north, whereas air entering Missouri from the northeast will tend to be cool and moist." (see Figure 1)

FIGURE 1

SOURCE REGIONS AND ATMOSPHERIC CHARACTERISTICS FOR AIR ARRIVING IN MISSOURI



Darkow goes on to explain, "Normally, the flow from one of the principal source regions will last for two or three days before switching to a different direction and source region. These transitions typically are accompanied by a frontal passage during which the change in wind direction, temperature, and moisture content, or any combination, is concentrated."

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[1]Grant L. Darkow, Missouri Weather Patterns and Their Impact on Agriculture, University Extension, University of Missouri-Columbia.

"In some instances, however, a particular flow pattern may be very persistent or dominant for a period of weeks or even months. These periods can lead to wet, dry, hot, or cold spells, and the extremes associated with these periods. These periods are characterized by particular upper air flow patterns and associated surface weather patterns." (see Figures 2a, 2b, 3a, 3b, 4a, and 4b).

Figure 2a. Upper Air Pattern (Precipitation Producing)

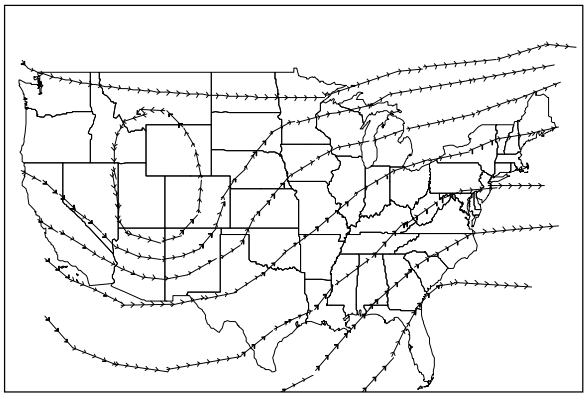


Figure 2b. Surface Air Pattern (Precipitation Producing)

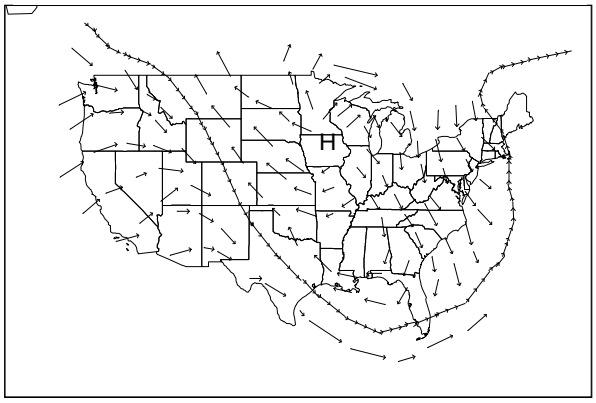


Figure 3a. Upper Air Pattern (Dry To Drought Producing)

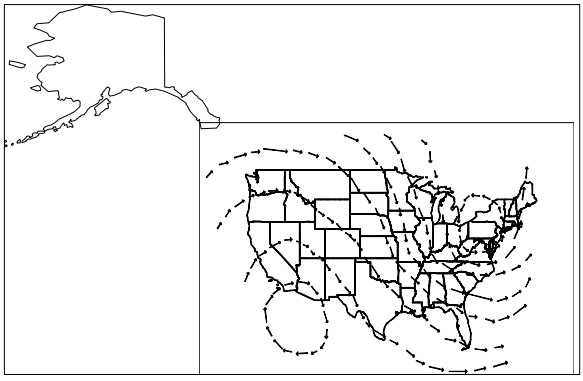


Figure 3b. Surface Air Pattern (Dry to Drought Producing)

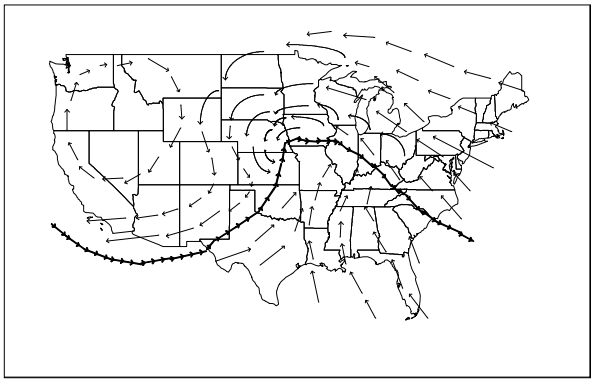


Figure 4a. Upper Air Pattern (Cold-Dry Case)

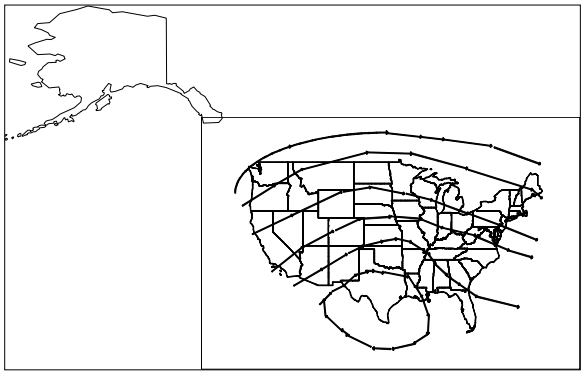
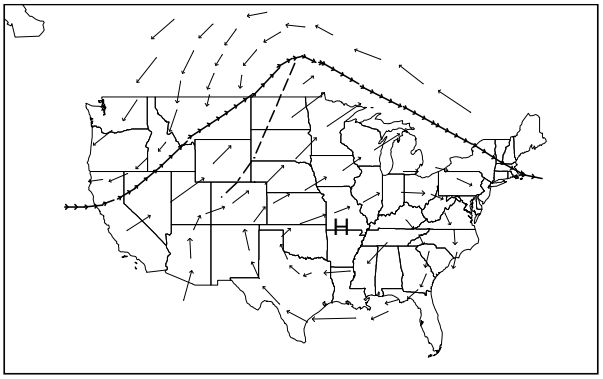


Figure 4b. Surface Air Pattern (Cold-Dry Case)



"The persistence of these weather patterns, and the possible resulting condition is the subject of several of the natural disasters discussed in this study. Specifically, floods, droughts, fires, heat waves, severe cold, and winter storms can be the result of the persistence of one of these weather patterns, whereas tornadoes can represent the outgrowth of rapid shifts in weather patterns. Knowing these patterns may assist in alerting disaster planners and the general public to the possibility of a developing emergency situation."

The Missouri State Emergency Operations Plan (2005) considers natural and man-made disasters, as discussed below.

NATURAL DISASTERS: Natural disasters can be complex, occurring with a wide range of intensities. Some events are instantaneous and offer no window of warning, such as earthquakes. Some offer a short window in which to alert the public to take actions, such as tornadoes or severe thunderstorms. Others occur less frequently and are typically more expansive, with some warning time to allow the public time to prepare, such as flooding. The following natural disasters may threaten Missouri:

- Tornadoes
- Floods
- Water (Interruptions and Drought)
- Earthquakes/Land Subsidence
- Wild Fires (Forest, Prairie, and Grasslands)
- Winter Storms and Severe Cold
- Heat Wave
- Severe Weather.

MAN-MADE DISASTERS: Each year sees an increase in man-made incidents, which can be just as devastating as natural disasters. The following man-made disasters could affect the State of Missouri:

- Structural and Urban Fires
- Utilities (Interruptions and Failures)
- Fixed Facility and Transportation Nuclear Hazards
- Hazardous Materials; Other Environmental Issues
- Mass Transportation Incident
- Nuclear Attack
- Conventional Attack
- Biological and Chemical Attack
- Terrorism
- Sabotage
- Civil Disorder
- Dam Failure
- Public Health Emergencies.

This hazard analysis addresses these man-made disasters.

In the U.S., 95 percent of all presidentially-declared disasters have been related to weather or flood events. In Missouri, 100 percent of the presidentially-declared disasters since 1975 have also been related to weather or flood events. Table 1 summarizes presidentially-declared disasters in Missouri since 1975.

TABLE 1

PRESIDENTIAL DISASTER DECLARATIONS FOR MISSOURI SINCE 1975

Declaration Date	Incident Type	No. Of Counties Designated	Type of Assistance By County*
May 3, 1975	Tornadoes, High Winds, Hail	4	IA & PA: 4
July 21, 1976	Severe Storms, Flooding	4	IA & PA: 4
September 24, 1976	Drought	94	PA Only: 94
May 7, 1977	Tornadoes, Flooding	7	IA & PA: 7
September 14, 1977	Severe Storms, Flooding	6	IA & PA: 6
March 12, 1979	Ice Jam, Flooding	2	PA Only: 2
April 21, 1979	Tornadoes, Torrential Rains, Flooding	17	IA Only: 1
			IA & PA: 16
May 15, 1980	Severe Storms, Tornadoes	1	IA Only: 1
August 26, 1982	Severe Storms, Flooding	3	IA Only: 1
			IA & PA: 2
December 10, 1982	Severe Storms, Flooding	17	IA Only: 18
			PA Only: 1
			IA & PA: 5
June 21, 1984	Severe Storms, Flooding	11	IA Only: 1
			PA Only: 8
			IA & PA: 2
October 14, 1986	Severe Storms, Flooding	30	IA Only: 7
			PA Only: 15
			IA & PA: 8
May 24, 1990	Severe Storms, Flooding	10	IA Only: 2
			IA & PA: 8
May 11, 1993	Severe Storms, Flooding	8	IA Only: 8
July 9, 1993	Severe Storms, Flooding	102	IA Only: 14
			IA & PA: 88
			(Cities) IA & PA: 3
December 1, 1993	Severe Storms, Tornadoes, Flooding	24	IA Only: 10
			IA and PA: 14
April 21, 1994	Severe Storms, Tornadoes, Flooding	18	IA Only: 18
June 2, 1995	Severe Storms, Tornadoes, Flooding	61	IA Only: 18
			IA & PA: 43
			(Cities) IA Only: 1
October 14, 1998	Severe Storms, Flash Flooding	19	IA and PA: 5
			PA Only: 14

Declaration Date	Incident Type	No. Of Counties Designated	Type of Assistance By County*
Oct. 19, 1998**	Severe Storms, Flash Flooding	2	IA Only: 2
			(Cities) IA Only: 1
April 20, 1999	Storms and Flooding	6	IA Only: 6
May 12, 2000	Thunderstorms, Flooding	10	IA: 10 IA and PA: 3
February 6, 2002	Ice Storm	43	IA Only: 43
			PA Only: 22
			IA and PA: 26
May 6, 2002	Severe Storms, Tornadoes	79	IA Only: 9
			PA Only: 31
			IA and PA: 39
May 6, 2003	Thunderstorms, Tornadoes, Flooding	76	IA Only: 42
			PA Only: 2
			IA and PA: 32
June 11, 2004	Tornado, Severe Storms, Flooding	37	IA: 37
September 10, 2005	Hurricane	114 & City of St. Louis	PA Only

Notes:
* IA denotes individual assistance; PA denotes public assistance.
** Declaration was for incident in July 1998, and approved October 19, 1998, following State appeal.

Table 2 shows the total amount of public assistance eligible for disaster declarations in Missouri from 1990 through 2004. Public assistance includes state and federal assistance for uninsured losses to public property and infrastructure within those counties included in the disaster declaration.

TABLE 2

PUBLIC ASSISTANCE FOR MISSOURI DISASTERS, 1990-2004

Date	DR No.	Number of Applicants	Damage Survey Reports/Project Worksheets	Total Amount Eligible
Spring 1990	0867	72	2,023	$9,461,555
Summer 1993	0995	901	14,479*	$140,859,657*
Fall 1993	1006	38	565*	$3,281,066*
Spring 1995	1054	329	2,275*	$17,404,027*
Fall 1998	1253	104	869	$11,217,783*
May 12, 2000	1328	31	183	$3,359,091.75
February 6, 2002	1403	247	654	$64,117,837.60
May 6, 2002	1412	338	1679	$47,657,061.62
May 6, 2003	1463	160	552	$21,494,879.54
	Totals	1,444	20,211*	$182,224,088*

Notes:
DR Disaster Recovery
* Figures as of June 1999.

Table 3 shows the total amount of individual assistance for individual assistance (IA)-declared disasters in Missouri from 1990 through 2004. Individual assistance includes state and federal assistance to individuals and families for uninsured losses within those counties included in the disaster declaration.

TABLE 3

INDIVIDUAL ASSISTANCE FOR MISSOURI FLOOD DISASTER, 1990-2004

Date	DR No.	Individual Assistance	Total Number of Applicants
Spring 1990	867	$4,000,000	700
Spring 1993	989	$1,591,241	447
Summer 1993	995	$65,690,976	15,478
November 1993	1006	$2,796,562	673
Spring 1994	1023	$2,116,639	779
Spring 1995	1054	$4,297,039	1,868
July 1998	1256	$1,093,865	1,763*
Fall 1998	1253	$1,251,679	1,623*
Spring 1999	1270	$559,725	203*
May 12, 2000	1328	$2,897,685.96	515
February 6, 2002	1403	$3,656,665.11	8,376
May 6, 2002	1412	$8,774,608.35	6,834
June 11, 2004	1524	$1,383,742.88	1,209
	Totals	$83,397,726	23,534

Notes:

DR Disaster Recovery
* Figures as of June 1999.

Table 4 shows the total projected federal expenditures through September 30, 1994, for four major disasters.

TABLE 4

FEDERAL DISASTER EXPENDITURES

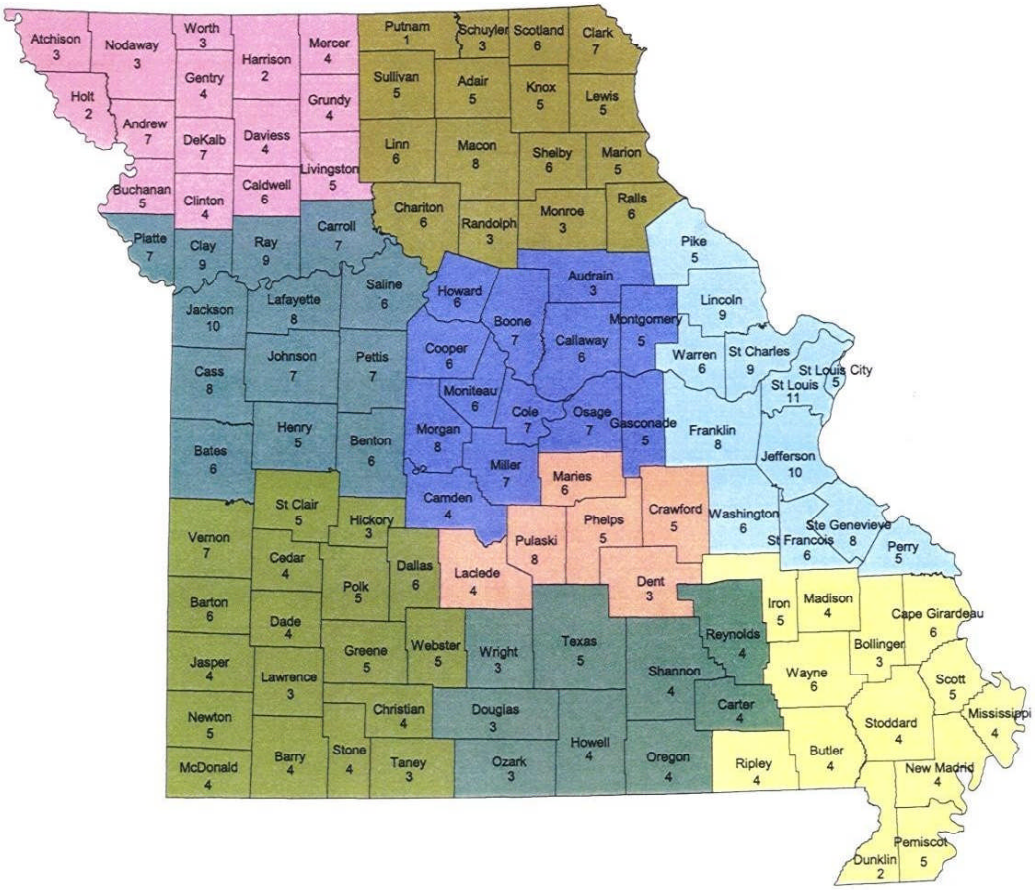
Disaster Incidents	Declaration Date	Projected Federal Expenditures (in Millions of Dollars)*
Hurricane Andrew	August 1992	3937.1
Hurricane Iniki	September 1992	554.2
Midwest Floods	Summer 1993	6011.7
Northridge Earthquake	January 1994	3714.6

Note:

* Expenditures through September 30, 1994.

Declared Disasters

1993-Present



FOREWORD

Lately, disasters appear to be occurring more frequently than during previous years. Federal, state, and local emergency managers need to prepare for, respond to, and recover from the increasing frequency and scope of disasters. While recent major disasters are memorable, the increased rate of occurrence is remarkable. Disasters in the 1980s were nearly twice as frequent as disasters in the 1970s. From 1993 through 2000 alone, Missouri experienced seven flood disasters, including one that exceeded the once-in-every–500-years flood levels. According to some weather forecasters, the country has entered a period of extremely destructive weather patterns.

The foundation for emergency preparedness is planning how to handle disasters. The art of perfecting how to respond to disasters is enhanced by the ability to bring together the key players for periodic exercises that emulate actual disasters.

This Hazard Analysis should be used by state and local officials to plan and prioritize resource allocations. Local officials can use information in this document to develop their own localized hazard analysis.

POPULATION

Missouri has a surface land area of 68,886 square miles and a population of 5,595,211 (2000 census).

Missouri ranks 17th among the 50 states in population; 18th in land area, and 27th in population density. Within the state are 960 incorporated cities, towns, and villages.

In the 1830 census, it's first, Missouri had a population of 140,455. The 1970 census showed 4,677,623 inhabitants, and the 1980 census showed 4,917,444 residents; in 1990, the census indicated another population increase to 5,117,073; in 2000, the census showed 5,595,211 inhabitants.

The population center of the United States was determined to lie in Phelps County approximate 2.8 miles east of Edgar Springs.

Missouri Population 5,595,211

Area Square Miles 68,886

Population Equivalent per Square Mile 81.2

Number of Incorporated Cities, Towns, and Villages 960

Number of Counties 114

Urban Population..... 69.4%

Cities with a Population of 50,000 or More 10

Counties with a Population Greater than 500,000 2
(St. Louis and Jackson)

Counties with a Population of 100,000 to 500,000 6
(Boone, Clay, Greene, Jasper, Jefferson, and St. Charles)

Counties with a Population of 50,000 to 100,000 9
(Buchanan, Cape Girardeau, Cass, Christian, Cole, Franklin, Newton, Platte, St. Francois)

Counties with a Population of 25,000 to 50,000 23

Counties with a Population of 15,000 to 25,000 27

Counties with a Population of 10,000 to 15,000 21

Counties with a Population of 1 to 10,000 26